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THE SURGICAL TREATMENT OF TUMORS WITHIN THE SPINAL CANAL.[1]

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The recent studies into the subject of spinal tumors by Bruns, of Tubingen,[2] and by Schlesinger, of Vienna,[3] have been so thorough and so searching, and have so ably carried forward the earlier researches of Horsley, Starr, Sherrington and many others, that it will be long before they are displaced, and seldom that new generalizations of importance will be added to theirs. Schlesinger alone reports fifty-six new cases, and summarizes four hundred, of which one hundred and four come from the post-mortem records of the Vienna General Hospital, which described a total of thirty-five thousand autopsies. All cases are excluded from Schlesinger's list, except where it was expressly stated that the spinal cord was involved, and extradural granulation-growths are not ranked as tumors even when they compressed the cord.

In spite of this array of tumor cases, the number of actual operations is still so small that additional records still have clinical lessons to teach.

The first patient to whose case I shall refer was a lady, aged fifty-two years, whose symptoms, which were very serious, proved to be due to a distinct and easily removable intradural fibroma. The first signs of her illness showed themselves in the early part of 1897, in the form of severe pain, occurring intermittently at first, but in more and more frequent attacks, over the lower ribs and the left side and down across the abdomen into the left groin. Even a year or two before this she had had an attack of severe pain in the abdomen, for which no cause could be assigned, and which may have been connected with the growth of the spinal tumor; but this had been followed by a prolonged free interval.

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[1] Read at the meeting of the Association of American Physicians, May, 1899.

[2] Die Geschwülste des N. Systems, 1898.

[3] Beiträge zur Klinik des Rückenmarks und Wirbeltumoren, 1898.

In March, 1897, she consulted Dr. R. H. Fitz, whose notes say that the pain was in the region of the transverse colon at first, later in the direction of the descending colon. At that time he saw no reason to ascribe the pain to anything more than neurasthenic and digestive disorders. That summer she went on a driving journey, and this is interesting, because the fact that the jolting of the carriage over country roads did not increase the pain helped later to the conclusion that the vertebral column had not been primarily involved. It must, however, be admitted that even in cases where jolting does cause pain we should not be justified in concluding that vertebral disease is present, for in the second case that I shall describe, which is one of intramedullary tumor, that sign was present to a striking degree.

In July of 1898—that is, about six months after the first onset of the pain in a definite form—the patient began to notice difficulty in using the left leg, especially when she was obliged to raise the weight of the body onto the step of a carriage or in going up stairs. This is still her greatest difficulty. Slowly but steadily the pain and weakness increased, and it is a noteworthy fact that the former seemed to be closely associated with the condition of the bowels. Not only was the pain made worse by the effort attending an evacuation, which, as has been suggested by Lacquer, may increase the congestion of the intravertebral veins, but the presence of gas in the bowels caused her great distress, and the periods shortly before and shortly after a movement were especially painful times.

Increase of pain in connection with intestinal movements or constipation has been repeatedly noted in cases of this sort, but with our patient it was a striking feature. The very presence of the gas which seemed to cause her so much distress was perhaps due to a paralytic condition of the bowel-walls. In the report of Ransom and Thompson's case, it is stated that the pain was not worse after breakfast or dinner, but was worse after supper, "when he had some wind."

Slight movements of the head, especially toward the left side, and even opening the mouth widely, would also bring on severe pain. It is impossible to believe that the slight contraction of the dorsal muscles required for these movements could, in itself, have disturbed the inflamed nerve-roots to any considerable degree, but for any one who has studied the neuroses dependent on association, it is quite easy to believe that a faint hint of possible further irritation, such as might attend really extensive movements of the vertebral column, could be given by these slight contractions, and would suffice to precipitate an explosion of pain.

In February, 1898, the patient consulted Dr. R. W. Lovett, literally crawling into his office, in the midst of an excruciating attack of pain which bent her double. From that time even to the present the bent-over position of the body has been assumed as the easiest one, and movements of standing still give rise to more or less discomfort, as they did then to intense pain. All through the spring of 1898 movements of every sort, and also the supine position, were very painful.

She was first seen by me in consultation with Dr. Lovett in the early part of June of the same year. At that time, although she looked in blooming health, she could walk only a few tottering steps, and not even those unassisted. The knee-jerks were greatly exaggerated, the left more so than the right, and ankle clonus was present. The sensibility to touch and pricking, which had previously been almost normal, was slightly, but only slightly, impaired over all the anterior surfaces of the legs and the lower part of the abdomen. At that time the pain, which had been most severe in the neighborhood of the groin, was most severe over the left flank and lower ribs, especially in the axillary line, where pressure was painful, as is indeed still the case.

The diagnosis of tumor at once suggested itself, as it had already to Dr. Lovett, and the question of operation was canvassed; but as she seemed to improve slightly, it was not decided upon until a few weeks later. Dr. Lovett had by that time been obliged to leave Boston for Europe, and left the patient in my charge, with the request to call in Dr. Warren to operate, if necessary, and this I shortly afterward decided to do.

Meantime, the impairment of sensibility and motion had increased until, at the time of the operation, the patient was unable to stand alone, and had begun to have considerable difficulty in controlling the bladder.

A careful examination as regards the sensibility, made three days before the operation, showed a very considerable impairment in the entire area of the distribution of the lumbar nerves—that is, over the anterior and lateral surfaces of the thighs, legs, and feet, although not everywhere to quite the same degree. This area of strongly marked impairment ceased abruptly at the groin on both sides, but slight impairment was observable over the whole abdomen, shading off gradually and finally disappearing at about the epigastric fold. On the whole, the sensibility of the left leg was distinctly better than that of the right, while the loss of motion there was much greater, a fairly certain indication that the left half of the cord had been invaded. Posteriorly, the impairment of sensibility was very much less, both as regards the buttocks and perineum, the back, and the thighs. It was, in fact, only on careful tests that any impairment was discovered in these areas. The umbilical reflex was entirely absent for the left side, but was faintly present at the first trial on the right side. In the affected areas the sensitiveness to pricking, temperature, changes of position, and contact were all involved, though not everywhere uniformly.

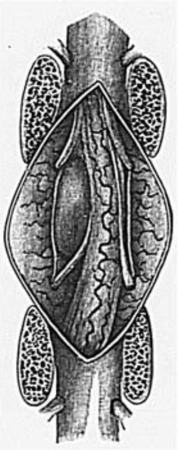
The character and sequence of symptoms were typical of tumor, consisting, as they did, first in pain, presumably due principally to nerve-root irritation, then in signs of cord pressure, causing impairment of sensation and motion, beginning in the toes and following, to some extent, the "Brown-Séquard" type.

The course of the disease, the fact that pain had been felt over the lower ribs, and that the impairment of sensibility, though slight, was observable as high as the area of the ninth dorsal, coupled with the fact that the patient had never shown any signs of other malignant growths, or of vertebral disease, made it reasonable to hope that we had to deal with an extramedullary tumor, not primarily involving the vertebral column, and situated as high as the ninth dorsal segment. The high degree of exaggeration of the knee-jerks and the presence of ankle clonus, taken together with the fact that the sphincters had not been involved, early or severely, and that the area of distribution of the sacral nerves was relatively free from signs of impaired sensibility, made it evident that the growth did not seriously involve the lumbar enlargement.

Dr. Warren gives the following account of the operation:

An incision six inches long was made from the seventh dorsal to the first lumbar spines. The muscular mass was rapidly dissected off on each side from the spines and the transverse processes, and held back by a broad retractor devised by Dr. R. B. Greenough. Hemorrhage was controlled by gauze packing so effectually that it was found at the end of the operation that it had not been necessary to tie a single ligature. The spines of the lower four dorsal vertebræ were next removed with cutting forceps, and the laminæ of the tenth and eleventh vertebræ were cut away, disclosing the dura but showing nothing abnormal. On removing the laminæ of the ninth dorsal vertebra a swelling was noticed in the cord beneath, which gave to the touch of the finger a marked sense of resistance. On laying open the cord at this point by an incision about one inch in length, a tumor about the size and shape of an olive was disclosed lying in the meshes of the pia on the left side. So loose were its adhesions that it was readily removed by the gentlest of movements with a blunt instrument, and with the slightest possible hemorrhage, which was controlled by a gentle pressure of a few moments' duration. No pedicle was found. The dura was stitched with three silk sutures. The muscles were brought into apposition by a few buried silk sutures, leaving a space for a temporary gauze drain. The skin was closed with silkworm-gut, two provisional sutures being left at the point of drainage. A dry dressing was applied.

During the first days after the operation the paralysis of both sensation and motion was intensified, and a zone of hyperæsthesia, such as had not been observed before, covered the abdomen and lower part of the chest, making the re-application of bandages a very painful process. These results we attributed to the œdema and the disorders of nutrition following the great change in vascular tension. Slight and vague sensations in the legs were felt on the second day, but the first sign of voluntary motion, and that only of the very slightest, showed itself three days later, and improvement in this respect was extremely slow. The bladder and rectum were not fully under voluntary control for many weeks, and not at all for the first three weeks.



The distress and pain induced by the helplessness, the hyperæsthesia of the abdomen, the constantly recurring cramps of the muscles of the thighs, legs, and feet, made a good deal of the first month a trying period, though it did not pass without frequent indications of better things to come. Perhaps even the strange illusions and hallucinations as to the position of the legs and feet, and with regard to movements, with which she was constantly harassed, were in reality signs of promise.

It was noticeable that, as in the Gowers and Horsley case, some of the early efforts at voluntary motion excited a spasmodic contraction, or a movement that seemed such to the patient, though it was in fact a mixture of voluntary motion and spasm.

The first return of perspiration to the legs, which had hitherto been wholly dry, showed itself after several weeks, the moisture being at first confined to the popliteal space, then affecting those surfaces of the legs which were in contact with each other.

It is always instructive to note how the spinal centres in spite of long disuse and serious injury may retain their power of recuperation, but this was still more strikingly shown in the first case of Gowers and Horsley than in ours. Their patient, who had been wholly paralyzed for months before the operation, and remained so for a month after the operation, was able at the end of a year to walk three miles.

The case recently published by Eskridge is in almost every particular a counterpart of the one here reported, but there, also, the improvement was more rapid.

On the whole, the history of the case since the operation has been one of slow but almost uninterrupted gain. At the present time the patient can walk fairly well with a cane, and short distances alone. Mounting the stairs or stepping into a carriage is very difficult without assistance from behind, but would doubtless be easier were the patient not so very stout. The body was for a long time bent strongly forward during attempts to stand and walk, but in this respect she has improved, though she has not wholly recovered. Every movement is possible, and most of them are fairly strong. She still has a good deal of pain from time to time, especially in the back and sides, but I am persuaded that to some extent these pains are due to association and habit, and persist mainly as an echo of the former condition.

A careful examination of the sensibility shows a very slight impairment, in all modes, over the greater part of the legs and abdomen, and even as high as the sixth rib in front; but, as before, there is hardly any impairment in the areas of distribution of the lower sacral nerves. There is still tenderness on pressure over the lower ribs in the axillary line, but this, too, I am inclined to attribute to the reviving of former associations. There is slight hyperæsthesia over the abdomen, as a reminder of the time when this was so great that the arranging of the bandage after the operation was a source of great distress. Her greatest discomfort is, however, a sensation of tension in the feet, causing a sense of "pulling" in the soles, and giving her a feeling as if the toes were being drawn upward, and until recently this has been associated with an actual hyperextension of the toes. Indeed, even now an effort of the will is sometimes required to overcome it. The knee-jerks, which remained extremely exaggerated for six months or more after the operation, have now become nearly normal, and ankle clonus has disappeared. Micturition is normal. The catamenia, which was absent for two or three months before the operation, has now become normal.

The points in which the case seems especially instructive are the following: The first is the wide extent of area over which pain was at times felt, which embraced the whole zone on the left side, lying between the groin, up to which point the loss of sensibility seemed to be almost complete to the epigastrium.

One must assume that the pain in the neighborhood of the groin was due not to the irritation of the nerve-root having its main distribution at that level but to that of a nerve-root given off one or two segments higher up, but reaching down to the point in question, for it is impossible to believe that this tumor could have extended down as far as to the origin of the twelfth dorsal root; and all the facts are fairly well accounted for if we accept the views of Sherrington, adopted by Bruns, that every given area on the trunk is supplied with at least three overlapping nerves.

Another point of interest is that the abdominal pain, even from the outset, was increased by the evacuation of the bowels, and by distention with gas. I was at first inclined, as stated above, to attribute this to increase in the abdominal pressure interfering with the spinal circulation, but it seems to me now more probable that the pain was a referred sensation, occurring on the principles laid down by Head as the outcome of his well-known researches. Most of the cases which Head studied were examples of pain excited by the stimulation of a normal spinal cord through excitations arising from diseased viscera, while in cases like the present we have, perhaps, an example of practically normal visceral excitations translated into painful cutaneous sensations, in consequence of the abnormally sensitive condition of the cord at certain levels.

Another significant fact is that the sensibility in the area of distribution of the sacral nerves was so much less affected than that in the distribution of the lumbar nerves. This seems, to judge by the reports, to be a common occurrence in cases of dorsal tumors. It was noted by Starr in one of his cases, and is especially commented on by Eskridge, who thinks it may be a mark of value in the differential diagnosis of tumor paralysis and Pott's paralysis. For the present I record the fact without offering an explanation, though I think that one is needed.

Finally, I would call attention to the fact that the patient, though greatly improved, and able to walk slowly without the aid of a cane, and free from any considerable pain, is yet far from well. Her present condition still mirrors the distresses both of the time before operation and the convalescence.

The two cases which I have next to report may, I hope, bring encouragement to those who are inclined to operate, even where no radical cure is to be expected.

The first case is apparently one of endothelioma of the spinal cord itself, which has been causing symptoms already for nineteen years. The patient is a gentleman, now forty-three years of age, who was seized in 1880, while in robust health, with intense pain in the lumbar region of the back, from which he remained a great sufferer for the next two years. It is noteworthy, in connection with the fact that the tumor probably started from the pia, that the jolting of a carriage greatly increased the pain. At the end of a little more than one year signs of compression or injury of the spinal cord first showed themselves, in the shape of impairment of sensibility to contact, and apparently to changes of position, and slight impairment of motion, in the feet, while at the same time the pain diminished and finally disappeared. The spinal cord symptoms continued to progress, until at the end of about nine years he became entirely paralyzed as regards sensation, motion, and control of the bladder and rectum.

In the intervening period the interesting dissociation of sensory symptoms showed itself, which was for a long time thought to be characteristic of intramedullary growths or syringomyelia, but which is now known to be the occasional result of pressure and other lesions. At a time, namely, when he could barely distinguish hot from cold water, and when only deep pricks caused pain, he could feel a fly walking upon the skin.

Some years after the paraplegia had become complete the patient's general condition grew so much worse that chances of relief were eagerly sought for. The cause of this state could not be positively ascertained, but he had lost much weight, his face appeared dusky, and he suffered greatly from frequent recurrences of singular attacks of sudden chill, followed by fever and sweating, of one, two, or three days' duration, which had occurred at intervals for a number of years, and have, indeed, continued to occur, though much less frequently and with much less severity, up to the present time. It was ascertained by careful investigation that these attacks were not of malarial origin, and the most probable alternative diagnoses seemed to be urethral infection or some influence starting from the spinal disease.

Although it was recognized as quite possible that the new growth, which was obviously present, lay within the cord itself, still the chance of an extramedullary tumor could not be wholly excluded, as will be readily conceived by any one who has made a careful study of the data on which these diagnoses are based. Therefore, after consultation with Drs. Walton, Keen, and Warren, and by letter with Dr. Mills, of Philadelphia, an operation was decided upon, and was performed by Dr. Keen, in 1891.

The cord was found enlarged, and dark-gray or bluish in color, and as no sign of external disease was present, the wound was sewed up. The recovery from the operation was steady, and convalescence was no sooner fairly established than the patient's general health, strength, and flesh began to improve, so that he has been in all respects markedly better ever since. Indeed, at the present time, though the new growth has obviously invaded the cord as high as the lower cervical region, he is in excellent physical condition, and the fever turns are of rare occurrence.

The favorable state of affairs following this operation was temporarily interrupted in 1895, when he suffered for a number of months with severe grinding pain across the neck and shoulders and in the arms, evidently due to the irritation of the new growth. This was relieved at first by applications of heat and ice, and he then remained free for more than a year. In December, 1897, however, the same pain returned, with increasing intensity, and grew steadily worse, so that toward the end of January it precluded sleep and became intolerable. After all measures that could be suggested had been tried in vain, I proposed to his physician, Dr. George Washburn, that another operation should be undertaken, at the site of the previous one, with a view of allowing cerebro-spinal fluid to drain off for some time, in the hope that changes in circulation and pressure might be induced which would at least break off for a time the habit of pain, for, as every one who is familiar with the treatment of neuralgias knows, the effect of habit counts for much in maintaining pain, and, on the other hand, a change of "set" of the nervous currents often serves to relieve it. The suggestion was an empirical one, but the result seemed to justify it. The operation was performed by Dr. Warren, who gives the following account: On February 10th the upper portion of the cicatrix was incised and the arches of the seventh, eighth, and ninth dorsal vertebræ removed. The cord at the seat of the old cicatrix was much thickened, and appeared like a soft sarcomatous tissue. Probing failed to reveal any collection of fluid. A gauze drain was left in and the wound was closed. The sinus formed by this drain closed in about two weeks, after the discharge of considerable cerebro-spinal fluid. A small bed-sore was easily controlled. An irritable spasmodic stricture caused some trouble at first, on the passage of the catheter, but finally yielded.

The patient never had another untoward symptom, except that for one week after the operation the numbness of the fingers of the left hand, by which he had been occasionally annoyed, increased. This, however, soon diminished, and is now less than before the operation. The pain ceased at once and has never returned.

The spinal cord at the point operated on seemed to have been converted into a dark-colored mass, not suggesting in any respect the normal cord. A piece of it which was excised, and afterward examined microscopically, proved to be made up of a mass of small round cells, probably endotheliomatous in nature. [Examination by Dr. E. W. Taylor and others].

The third case is of interest, from the relatively favorable outcome of operation in a case essentially incurable, and also because it is one where a sarcomatous growth seems distinctly to have been initiated by injury.

The patient, who at the time of my examination was a young man, aged twenty-four years, had had, three years before, a severe fall from a ladder, in the course of which his neck received a severe wrench, followed by stiffness and impairment of movement to the left, due, as I am inclined to believe, to a partial dislocation. He was able to return to work after six weeks, but in the two subsequent years his neck was injured twice again. Six to eight months before I saw him he began to have difficulty in walking, then in the use of his hands, although, strangely enough, disorders of sensibility, either subjective or objective, have been trifling from first to last. The knee-jerks and wrist-jerks became exaggerated, and ankle clonus soon developed. Both legs and arms became wholly paralyzed, with the exception of trifling movements, and gradually the breathing became affected, so that eventually it was possible only through the diaphragm and accessory neck muscles.

When matters arrived at this point, and death seemed inevitable, he consented to an operation, which I had already advised. I had felt a prominent vertebral body in the pharynx, and believed it probable that he was suffering from caries of the upper cervical vertebræ, with extradural cord compression; but it should be said that my colleague, Dr. G. L. Walton, was less inclined to favor this view than that of sarcoma, which proved to be the correct one.

The operation was done by Dr. J. W. Elliot, on June 20, 1898. The posterior surface of the axis was found eroded, and on breaking it away with the forceps a sarcomatous mass was found beneath, which apparently penetrated directly to the spinal cord. This was removed and its base curetted, and the surrounding parts, which seemed also to be infiltrated by new growth, were cleared up as far as possible. The growth was pronounced by Dr. W. F. Whitney a giant-cell sarcoma.

The patient's breathing improved at once, and after a few days the voluntary motion began to return to both arms and legs. He left the hospital in three weeks much relieved, though still unable to walk alone. This improvement was soon followed by a relapse to a certain degree, but this again by renewed improvement some weeks later. Since then he has been gaining steadily, and is still gaining. An examination made within a month finds him in good flesh and color, breathing without effort, free from pain. He has no subjective impairment of sensibility consequence, and a careful examination shows that the sense of contact, temperature, pain, and position is almost but not quite normal below the neck. The breathing is still mainly diaphragmatic, but the costal muscles also act.

Almost all motions of both arms and legs are possible, and though weakness and rigidity and spasm still incapacitate him from getting about alone, he is able to do many things for himself, and looks forward, with apparent justice, to further improvement.

The number of the operated cases already published has increased from the twenty reported by Bruns, in 1898, to thirty three, which have been collected for us by Dr. Robert B. Greenough, who assisted Dr. Warren at both of his operations, and to whom we take this occasion to express our appreciative thanks. This list does not embrace the five cases of pressure paralysis following Pott's disease, which were included by Starr in his table, nor Starr's own case of extradural tubercular tumor. It is true that these cases differ from the great majority of the Pott's paralysis cases, in that the pressure was exerted by thick masses of organized tissue-forming tumors on the dorsal surface of the dura; but, nevertheless, it seemed to me that a consideration of them would open the large subject of Pott's disease, upon which we could not enter.

Of the thirty-three operations reported in the table, seven led to recovery and ten to more or less improvement, although only in five of these latter, amongst which our first case was included, was the improvement considerable or lasting.

Among the cases reported as "recovered" there are two where the records are not sufficiently perfect to allow of verification of the statement. In one other case (Davies-Colley) the tumor removed was a sarcoma, so that although the patient was able to return to work the eventual outcome is perhaps uncertain.

In ten, perhaps twelve, cases operation seems to have hastened death, which occurred five times through meningitis, septicæmia, or hemorrhage (once, in a case of epithelioma); five times through shock, exhaustion or other causes. It is fair to believe that with improved methods of operation and diagnosis the danger from some of these agencies would diminish, but at the worst the figures show but one out of three chances for hastened death against even chances for some improvement.

In nine cases the operation seems to have made little difference in the progress of the case, and it should be remembered that even with the others the death which was hastened was bound to occur soon at any rate.

The really satisfactory cases for permanent or complete recovery or substantial improvement are few in number. The best results were in the three fibroma cases, in one, each, of psammoma, lipoma, and sarcoma, and in two of echinococcus. The occurrence of the two last fibroma cases (Eskridge and Freeman's, and ours), so near together might suggest that they are of frequent occurrence, but in fact they are separated by twelve years from that of Gowers and Horsley, which was the first successful case ever reported, and which did so much to stimulate the surgeon's hope.

It is interesting to note that in spite of the difficulty—or impossibility in some cases—of deciding positively as to the exact position of a tumor, or even whether it is inside or outside the cord itself, no case *has been reported* where an operation was done on a wholly mistaken diagnosis. In one case, however, the tumor was missed because it lay above the incision, and in another, contributed by Bruns himself, a growth which was supposed to be extramedullary proved eventually to be a diffuse sarcomatous infiltration of the roots and outer portions of the cord.

SPINAL TUMORS OPERATED ON.

No.	Reporter.	Reference.	Date.	Tumor.	Height.	Situation.	Result.
1	Bruns and Kredel.	Arch. Psychiatrie, Bd. xxviii.	1892	Sarcoma.	9 D to lower lumbar	Intradural.	Death.
2	Bruns and Lindemann.	Neurol. Centralbl., 1894, p. 359.	1894	Sarcoma.	3 to 6 D	Extradural.	Death in 1 day.
3	Church and Eisendrath.	Amer. Journ. Med. Sci., 1892, p. 395.	1890	Spindle-cell sarcoma.	4 to 5 D	Intramedull.	Death in 4 days.
4	Clark.	Brain, 1895.	......	Endothelioma.	Lower C	Extradural.	Death from hemorrh'ge
5	Curtis.	New York Record, March 5, 1898.	1898	Cancer.	6 D	Extradural.	Death in 16 days.
6	Davies-Colley.	Clin. Soc. London, 1892, p. 163.	1892	"Fusiform" spindle-cell sarcoma.	5 to 6 D	Extradural.	Recovery.
7	Eskridge and Rogers.	Phila. Med. Journ., Feb. 19, 1898.	......	Tumor of vertebræ.	4 to 5 D	Extradural.	Death in 9 days.
8	Eskridge and Freeman.	Phila. Med. Journ., Dec. 10, 1898.	1897	Fibroma.	3 to 4	Intradural.	Recovery.
9	Gerster.	N. Y. Med. Journ., 1892.	......	Sarcoma.	5 D	Intra & extradural.	Improvement.
10	Gowers and Horsley.	Med. Chir. Trans., 1888, p. 407.	1887	Fibro-myxoma.	3 to 4 D	....	Recovery.
11	Horsley.	Brit. Med. Journ., 1890, part II.	......	?	....	Intradural.	Death in 1 day.
12	Horsley.	Clin. Journ., Lond., 1896-97, ix. p. 177.	......	Echinococcus.	(3L n'rve) 12 D V	Extradural.	Recovery?
13	Ignatoff.	Vayenno Med. Journ., St. Petersburg, 1896, I. sect. clxxxvii. pp.30-32.	1894	Chondrosarcoma.	5 to 7 D	Extradural.	Improvement.
14	Kümmell.	Arch. klin. Chir., 1893, Bd. l.	1893	Sarcoma.	3 to 4 D	....	Improvement.
15	Lichtheim and Mikulicz.	Deut. med. Woch., 1891, p. 1386.	1890	Psammoma.	9 D	Intradural.	Death in 2 days.
16	Lichtheim and Mikulicz.	Deut. med. Woch., 1891, p. 1386.	1890	Psammoma.	4 D	Intradural	Marked improvement.
17	Lloyd.	Amer. Med. Surg. Bull., New York, 1896, x. p. 659.	1896	Echinococcus.	8 D to 5 L	Extradural.	Recovery.
18	Laqueur and Rehu.	Neurol. Centralbl., 1891, p. 193.	......	Lymphangioma.	Sacrum	Extradural.	Marked improvement.
19	Munroe.	To be published later.	......	Sarcoma.	Lumbar	....	Death.
20	Pescarolo.	La Riforma Med., 1892, X. Internal. Cong., Berlin, iv. p. 59.	......	....	2 to 5 D		
21	Putnam and Elliot.	....	1899	Sarcoma.	2 and 3 D	Cerv. vert.	Improvement.
22	Putnam and Warren.	....	1899	Fibroma.	9 D	Intradural.	Great improvement.
23	Quensel and Garten.	Neurol. Centralbl., 1898, xvii. p. 482.	1896	Sarcoma.	7 to 8 D	Extradural.	Death in 6 days.
24	Ransom and Anderson.	Brit. Med. Journ., 1891, ii. p. 1144.	......	Echinococcus.	10 D	Extradural.	Death in 3 days.
25	Ransom and Thompson.	Brit. Med. Journ., 1894, i. p. 395.	......	Round-celled sarcoma.	8 D	Extradural.	Death in 6 days.
26	Roy.	N. Y. Med. Rec., 1890, ii. p. 564.	1890	?	9 to 12 D	Intradural.	Recovery.
27	Sänger and Krause.	Munch. m. Woch., 1894, p. 22.	1894	Sarcoma.	6 D	Extradural?	Death in 4 days.
28	Sonnenburg.	Verh. deut. Gesell. Chir., 18th Cong., Berlin, 1889.	......	Sarcoma.	Lower D	Extradural.	Death in 6 weeks.
29	Starr and Abbe.	N. Y. Med. Rec., 1890, p. 85	......	Sarcoma.	8 to 9 D	Extradural.	Death in 9 days.
30	Starr and McCosh.	Amer. Journ. Med. Sci., June, 1895.	......	Sarcoma.	5 D (7 D)	Extradural.	Death in 21 days.
31	Starr and McCosh.	" " "	......	Lipomata.	Lumbar	Extradural.	Imprvem't; death in 6 mos. from upper dorsal caries.
32	Szekeres.	Pester Med. Chir. Presse, 1894, p. 43.	......	Echinococcus.	....	Extradural.	Recovery.
33	Welms and Trendelenburg.	Beitr. z. klin. Chir., 1898, xxi. p. 151.	1896	Echinococcus.	2 L to sacrum	Extradural.	Death in 6 mos. from amyloid.

A few cases—not operative—are on record where the diagnosis, though carefully made, proved wholly erroneous.

How large is the surgeon's field for operation in the spinal canal? This is a question which the physician has to consider, in view of the great uncertainty which must attend his diagnosis as regards the exact position of the tumor—namely, whether it lies dorsally or ventrally with relation to the cord. The possibility of drawing the cord aside to a certain extent, cutting one or two dorsal nerve-roots, if necessary to accomplish it, has been contemplated by various surgeons. In fact, Kümmell[1] removed a laterally-placed sarcoma of the body of a vertebra and scraped out the cavity, but no tumor has, to my knowledge, been removed from the ventral portion of a vertebral body.

It is an important inquiry how nearly, in the cases which are counted as successful, such as the first of those reported by us, the improvement is likely to approach absolute recovery; to what extent the degree of probable improvement may be foretold; and what signs make its occurrence improbable.

Very few cases are actually at our command—if we omit those of Pott's disease—for answering this question. In most of the cases that ended in recovery the paraplegia had been complete but for a very brief period, but in the Gowers and Horsley case it had existed for several months. In Pescarolo's[2] case, where the patient had been paralyzed for some years, there was no improvement at the end of five months after operation. No one need be disappointed at the occurrence of a temporary increase of paralysis after operation, or at a delay in the onset of signs of improvement. Some return of sensibility is likely to show itself by the end of a day or two at the latest, but no voluntary motion may occur for one or two weeks. The earlier movements, as in the Gowers and Horsley case, and in ours, although initiated by voluntary effort, may seem to the patient, and at first to the physician, to have all the character of involuntary spasm.

It is probable that, as a rule, the prospect is better in the cases where the paralysis develops slowly, as from the gradually increasing pressure of the large flat masses of inflammatory exudation met with in Pott's disease, than where it comes on rapidly, since in the latter case the nerve-elements and bloodvessels do not have the same opportunity to accommodate themselves to the lessening space. In cases of the former sort, a delay of a few weeks, or even days, in operating may be of far more consequence than that of an equal number of months under other circumstances.

Schlesinger points out, and his opinion is corroborated by that of others, that the cause of the paralysis is complex, and that it includes the effects of pressure, anæmia, necrosis, œdema, and also of inflammation. The latter element is of special importance, because, in the opinion of Horsley[1] and others, it is liable to increase after operation, though, on the other hand, Allingham offers evidence that it may occasionally diminish. Indications that the cord is not only compressed but softened are, however, in Bruns' opinion, not a positive contraindication to operation.

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[1] Arch. für. Chirurgie, 1895.

[2] Citation by Bruns.

To what extent is it worth while to operate where there is little prospect of inducing a cure? This is a question which each physician and surgeon must answer for himself, and with reference to the individual circumstances of each case. I do not, myself, believe that the surgeon should throw the decision too much upon the patient. The alternatives which he is bound to offer (let him express them as simply as he may) are bound to be bewildering, and the choice which the patient makes is far less likely to be a good one than that which the conscientious physician can make for him.

Bruns believes that when the diagnosis of tumor is fairly made it is usually best to operate, but that this diagnosis can rarely be conclusive until signs of actual cord pressure have appeared, and even then the outcome is largely a lottery.

The second and third cases reported by us give some ground for greater hopefulness in prognosis than an interpretation of reported facts in the light of our narrow knowledge might seem to justify. Sometimes the operation appears, in accordance with some subtle principle, to induce to a new "set" to the tendencies at work. The tumor may perhaps be led to grow in a new direction; or, as in the second case reported by us, the temporary relief to pain may introduce a fairly persistent relief. The history of neuralgias of other sorts gives abundant illustrations of this sequence. Thus the biographer of Lord Lawrence tells how, while he was Governor of the Northwestern Provinces of India, and had been for a long time a sufferer from facial neuralgia—usually so intractable—the news was brought of the outbreak of the great mutiny, which compelled him to work day and night in despatching troops. Under this powerful stimulus, and in spite of fatigue, the neuralgia disappeared, never, it is said, to return.

Cases of intramedullary tumor, as one might suppose, have never been operated on successfully. The nearest approach to this was in the case of Church and Eisendrath, where a well-defined spindle-celled sarcoma was removed from the posterior half of the cord. Unfortunately the wound became septic; had it not been so, the writers think the patient might have done well. Horsley[2] and Crofts (cited by Horsley) have tapped, the one the cavity in a case of syringomyelia (case of Gowers), the other a "cyst"; but with only temporary improvement. I have done a "lumbar puncture" in a case of syringomyelia, hoping that the altered circulatory conditions might bring relief to the persistent pain, but without effect.

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[1] British Medical Journal, 1890.

[2] Ibid.

Finally, I would say, in spite of not wishing to enter on the large subject of the localizing diagnosis of tumors, that physicians and surgeons who have such cases in charge can do good service by making very careful observation as to the exact areas in which the sensibility is altered, and the character of this alteration. It will be generally found that, in spite of many routine statements to the contrary, it is not the line of the ribs, but lines more or less at right angles to the long axis of the body, that are followed by the upper margin of the affected surface, and that the back and the sacral areas tend to escape unless the lumbar portion is involved, and occasionally—contrary to the usual statement—with tumors compressing the cauda equina. [Lacquer.] It may also be noted that pain occurs sometimes when no cause can be assigned, and fails, as in our third case, where it would pre-eminently be expected. (This latter will, I think, be oftenest noted with tumors of the cervical segments.)

It is an interesting fact, that in the diagnosis of spinal tumors as regards localization, and in framing an explanation of the symptoms, we have now begun to draw on more subtle principles than those of anatomy. Prominent among the newer studies in this direction are those of Head (*Brain*, 1895), whose researches were primarily undertaken for the investigation of the relation between disorders of the viscera and the hyperæsthesia of definite areas of the skin. Head finds that his skin-areas correspond neither to the distribution of peripheral nerves nor of the spinal nerve-roots, and believes that they represent spinal segments of the gray matter. The boundaries of his areas do not run parallel with the ribs, but are at right angles with the long axis of the body, thus corresponding with a type of arrangement which has been repeatedly noted in descriptions of sensory disorders resulting from spinal tumors. He also calls attention to the fact that the increased sensitiveness of the skin, associated with visceral irritation, is not a real increase of the contact sense, but is to be classed as a painful affection—*i. e.*, as a hyperalgesia and not a true hyperæsthesia. This is also true of the area of sensitiveness which lies just above that of anæsthesia in tumor cases.

It can hardly be doubted that some of the curious relationships between certain conditions of the visceral organs and the pain, in spinal tumor, are best explained by the aid of Head's observations. Thus in our first case one of the most serious causes of exacerbations of pain was the slight distention of the bowels with gas, and the conditions present immediately before and after a movement. One might possibly adopt the explanation suggested by Lacquer for the pain attendant on straining at stool—namely, the disturbance in the abdominal and secondarily the spinal circulation, but it is at least an equally reasonable hypothesis that the effect was due to the slight but additional irritation of the affected segments of the spinal cord. Even though the pain was not strictly confined to the cutaneous areas most closely related to some particular viscus, but represented only an increase of the habitual pain due to the tumor, the same explanation would hold good, for Head's observations show that these sensory reflexes follow a law similar to that which governs motor reflexes, in that two factors are at work. As soon as any stimulus reaches the gray matter of the spinal cord it instantly diffuses itself, and although the effect most likely to follow will tend to confine itself to the level at which the nerve conveying the stimulus first terminates, yet if a peculiarly irritable condition of the gray matter exists at another level the response may come from that, and the next time the same result may occur more readily through the action of the law of association and habit. It is in the same way, I think, that the effect of gaping and sneezing, and even, as in our case, slight movements of the head and face, come to exert such a strong influence in exciting pain. It is doubtless true that these movements produce slight changes of tension within the spinal canal, but these must be so slight that they would fail to be effective for harm had they not been at the same time associated with stronger movements which were capable of drawing, to a material degree, on the inflamed parts.

The consideration of our first case calls to mind another point of both theoretical and practical interest. It was, namely, very noticeable that the areas supplied by the lower sacral nerves—that is, the well-known saddle-back area—retained its sensibility to a far greater degree than that supplied by the lumbar portion of the cord, although that was wholly below the point of pressure. This condition of affairs is found repeated in many of the observations, and Eskridge calls attention to this as perhaps characteristic of tumor cases. One may offer theoretical explanations based on mechanical principles, but the fact is worthy of being placed side by side with the observations (not invariably correct) [Lacquer], that when the cauda equina, as a whole, is injured, it is pre-eminently these same lower sacral nerves, though they occupy a protected position in the middle of the aggregate bundle, which are most affected; and also with the fact pointed out by Bruns, that the root symptoms provoked by intradural but extra-medullary tumors are usually referable not to pressure upon the nerve-roots in their course but to pressure exerted at their point of exit from the cord.

With regard to the favorable results which followed operation in the second and third cases reported by us, it would be hazardous to assert that they are so clearly attributable to the operation as to justify repetition of the procedure in similar cases. This is not the first time that the spinal canal has been opened in cases of intramedullary tumors, though sometimes the condition actually found was a surprise. This happened in the case reported with such care by Bruns, and there also a considerable degree of improvement as regards pain did, as a matter of fact, follow the operation.

The consideration of the lesions met with in these compression cases, as shown by the history of Pott's disease, myelitis, and of the tumor cases reported by Bruns, Schlesinger and others, suggests reasons enough why the improvement in some of these cases is so much greater than it is in others. For some reason not clearly definable the effects of compression sometimes lead to hemorrhages and necrotic softening, both at the point of the greatest narrowing and occasionally a little higher than this as well, while at other times such lesions are wholly absent, although the stricture may reach a high degree.

A FIFTH CASE OF "FUNGOUS FOOT" IN AMERICA.

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The history by Dr. Arwine is brief, but the best that could be obtained.

Pedro B.; was born in Southwestern Texas; of Mexican parentage; aged forty-five years; married; six children. Family history good; no history of syphilis. He lived on a ranch thirty or forty miles from Fort Ringgold; had never lived elsewhere. The disease began about the year 1887 with severe pain in the left foot, lasting thirty-six hours. After this a red spot appeared on the foot. The man had chills and fever; no cause for the condition was known. Throughout almost the whole course of the disease the pain continued; it was most severe at night, and was worse in summer than in winter; toward the last it subsided. The only treatment was the use of a few simple household remedies. The local physicians diagnosticated elephantiasis, and advised amputation.

He came to Dr. Arwine on March 5 (or 6), 1889, complaining of the leg being too heavy to carry; there was then no pain. On the 16th Dr. Arwine amputated; there was but little shock; about eight arteries in addition to the tibials, all of which were much enlarged, were tied. Recovery was complete and without event; the more gratifying because the man's surroundings at the time of the operation were quite unsanitary.

The amputated part was sent to the Army Medical Museum, but was not in good preservation when received. It is numbered 11,699 in the pathological series, and consists of the left foot and lower half of the